



# MACHAKOS UNIVERSITY

University Examinations 2022/2023

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR FIRST SEMESTER EXAMINATION FOR  
BACHELOR OF SCIENCE (TELECOMMUNICATION INFORMATION)  
BACHELOR OF EDUCATION (SCIENCE),  
BACHELOR OF EDUCATION (SPECIAL NEEDS)  
BACHELOR OF SCIENCE (MATHEMATICS)

SPH 100: MECHANICS I

DATE:

TIME:

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**INSTRUCTIONS:**

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

**YOU MAY FIND THIS USEFUL:**

You may need to use the following constants

- Density of water =  $1.0 \times 10^3 \text{ kg/m}^3$
- Acceleration due to gravity  $g = 9.81 \text{ m/s}^2$
- Universal gravitational constant  $G = 6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$
- Mean radius of the earth  $R_e = 6400 \text{ km}$
- Mass of the Earth,  $M_e = 5.98 \times 10^{24} \text{ kg}$
- Mass of the Sun,  $M_s = 1.98 \times 10^{30} \text{ kg}$
- Permittivity of free-space,  $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$

## SECTION A (COMPULSORY)

### QUESTION ONE (30 MARKS)

- a) State three basic aspects a measurement. (3 marks)
- b) State the third newton`s law of motion and briefly describe its application in our daily lives. (3marks)
- c) Show that  $v = at$  expression where  $v$  represents speed  $a$  represents acceleration and  $t$  represents an instant of time is dimensionally correct. (4 marks)
- d) A body moving with uniform acceleration of  $20 \text{ m/s}^2$  covers a distance of 640 m. (4 marks)  
If the initial velocity was 60 m/s calculate the final velocity of the body.
- e) Mr. Green is driving north on a straight two-lane road at a constant speed of 88 km/h. A truck travelling at 104 km/h is approaching Mr. Green on the other lane. Calculate Mr. Green`s velocity relative to that of the truck. (4 marks)
- f) A block of 150 N weight is resting on a rough horizontal table. What horizontal force P is required to move the block with acceleration of  $1.5 \text{ m/s}^2$ . Coefficient of kinetic friction between the constant surfaces is 0.2. (4 marks)
- g) A football player hits the ball to impart an initial velocity of 30 m/s at an angle of  $15^\circ$  with the horizontal from a point that is 15 m from the goal post (of 2.2 m height). Determine whether the ball will enter the goal post or not. (4 marks)
- h) Determine the gravitational attraction between the earth and a 90 kg man if the man is in an airplane 13000 metres above the earth`s surface. (4 marks)

## SECTION B

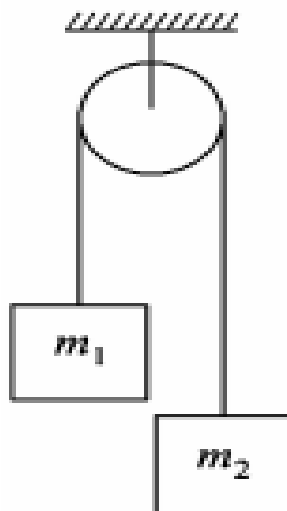
### QUESTION TWO (20 MARKS)

- a) Differentiate between systematic and random errors (2 marks)
- b) The voltage across a wire is  $(100 \pm 5) \text{ V}$  and the current passing through it is  $(10 \pm 0.2) \text{ A}$ . Find the resistance of the current flow on the wire (5 marks)
- c) The force F acting on a body moving in a circular path depends on the mass of the body (M), Velocity (V) and radius (r) of the circular path. Obtain the expression for the force by dimensional analysis method (**take K=1**) (5 marks)

- d) A body is thrown from the top of a cliff 20 m high with the horizontal velocity of 10 m/s. Calculate
- Time taken for all the ball to strike the ground (3 marks)
  - Distance from the foot of the cliff to where the ball strikes the ground (3 marks)
  - The vertical velocity at the time it strikes the ground (2 marks)

**QUESTION THREE (20 MARKS)**

- State the Newton`s second law of motion (2 marks)
- State and describe the two types of collisions (4 marks)
- A bullet of mass 10 g travelling horizontally at a speed of 100 m/s embeds itself in a block of wood of mass 990g suspended on a string so that it can swing freely. Calculate
  - Vertical height through which the block rises (4marks)
  - How much of the bullet`s energy becomes internal energy (4 marks)
- Two blocks of masses  $M_1$  and  $M_2$  are suspended by an inextensible string passing over a massless and frictionless pulley as shown below. When released from rest, determine the expressions and value for the acceleration of the system and the tension in the string. Take  $M_1 = 2$  kg and  $M_2 = 3$  kg (6 marks)



**QUESTION FOUR (20 MARKS)**

- a) Define one radian. (1 mark)
- b) A model car moves round a circular track of radius 0.3 m at 2 revolutions per second. Calculate.
- i. The angular speed,  $\omega$  (3 marks)
  - ii. The period, T (3 marks)
  - iii. The speed  $v$ , of the car. (3 marks)
  - iv. The angular speed of the car if it moves with a uniform speed of  $2 \text{ ms}^{-1}$  in a circle of radius 0.4 m (3 marks)
- c) A pendulum of mass 50 g is attached to one end of the string of length 1.5 m. the bob moves in a horizontal circle in such a way that the string is inclined at  $8^\circ$  to the vertical. Calculate.
- i. The tension on the string (4 marks)
  - ii. The period of the motion (3 marks)

#### QUESTION FIVE (20 MARKS)

- a) State Kepler's laws governing planetary and satellite motion. (3 marks)
- b) An asteroid, headed directly toward Earth, has a speed of 12 km/s relative to the planet when the asteroid is 10 Earth's radii from Earth's center. Neglecting the effects of Earth's atmosphere on the asteroid. Find the asteroid's speed  $V_f$  when it reaches Earth's surface. (6 marks)
- c) Comet Halley orbits the Sun with a period of 76 years and, in 1986, had a distance of closest approach to the Sun, its *perihelion distance*  $R_p$ , of  $8.9 \times 10^{10}$  m.
- i. Calculate the comet's farthest distance from the Sun, which is called its *aphelion distance*  $R_a$ ? (6 marks)
  - ii. Calculate the eccentricity  $e$  of the orbit of comet Halley. (5 marks)